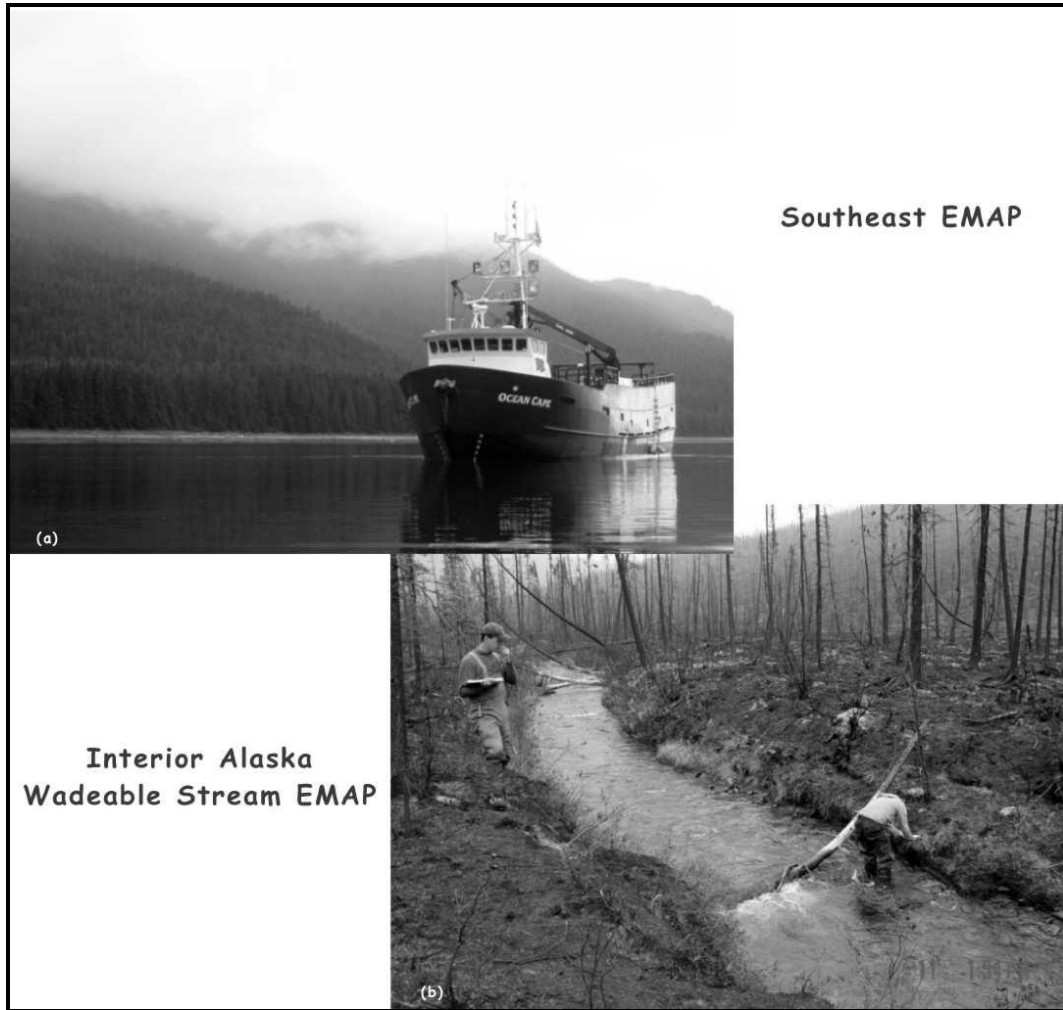


Alaska Department of Environmental Conservation's Environmental Monitoring & Assessment Program Implementation Strategy



**Alaska Department of Environmental Conservation
Division of Water
Water Quality Monitoring & Assessment Program**

March 2005

(a) ADEC photo of Research Vessel Ocean Cape during Southeast EMAP 2004. (b) ACDE photo of Interior Alaska Wadeable Stream EMAP survey on Cripple Creek a watershed burned by the Boundary Fire in 2004.

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1.0 Introduction to EMAP

The Alaska Department of Environmental Conservation's (ADEC) Environmental Monitoring and Assessment Program (EMAP) incorporates EPA's probabilistic stratified random sampling design. The design is coupled with a common set of survey indicators to provide for a statistically unbiased, objective assessment of the overall environmental condition of Alaska's waters streams (EPA, 2001).

Unlike targeted studies, EMAP is focused on the "state of the region", providing resource managers with scientifically based data of known statistical confidence, with assessments of a region's ecological resources and the likely causes of effects that are observed. EMAP protocols are standardized, and are used by all participating states. This improves the comparability of data among the EMAP participants allowing for better regional assessment and prioritization of stressors and impacts. In addition, EMAP provides standard methods and procedures for sharing and managing comparable data sets held in a quality controlled, data management system.

EMAP provides essentially two tools to ADEC, first the bioassessment framework (integrated physical, chemical and biological measurements) and secondly, the statistically based design(s) procedures. This statistical design is critical to being able to make inferences of the aquatic ecological condition and to assess trends

over time to *all waters* in a region from a sub-set of waters actually sampled. Targeted non-probabilistic sampling, typically designed to answer specific localized questions cannot answer regional questions, such as "What are the conditions of all the wadeable streams in Alaska in the Tanana River drainage?" EMAP protocols are designed to provide general conclusions about the biotic and abiotic conditions within a study area, which can then be used for comparison with other regions of Alaska and the United States. A graphical summary of biological quality and a ranking of stressors for an EMAP assessment of stream conditions in the mid-Atlantic highlands is shown in Figure 1. This type of information cannot be obtained from targeted sampling programs, principally focused on specific "problem" areas.

Principal Operational Objectives for ADEC Division of Water EMAP

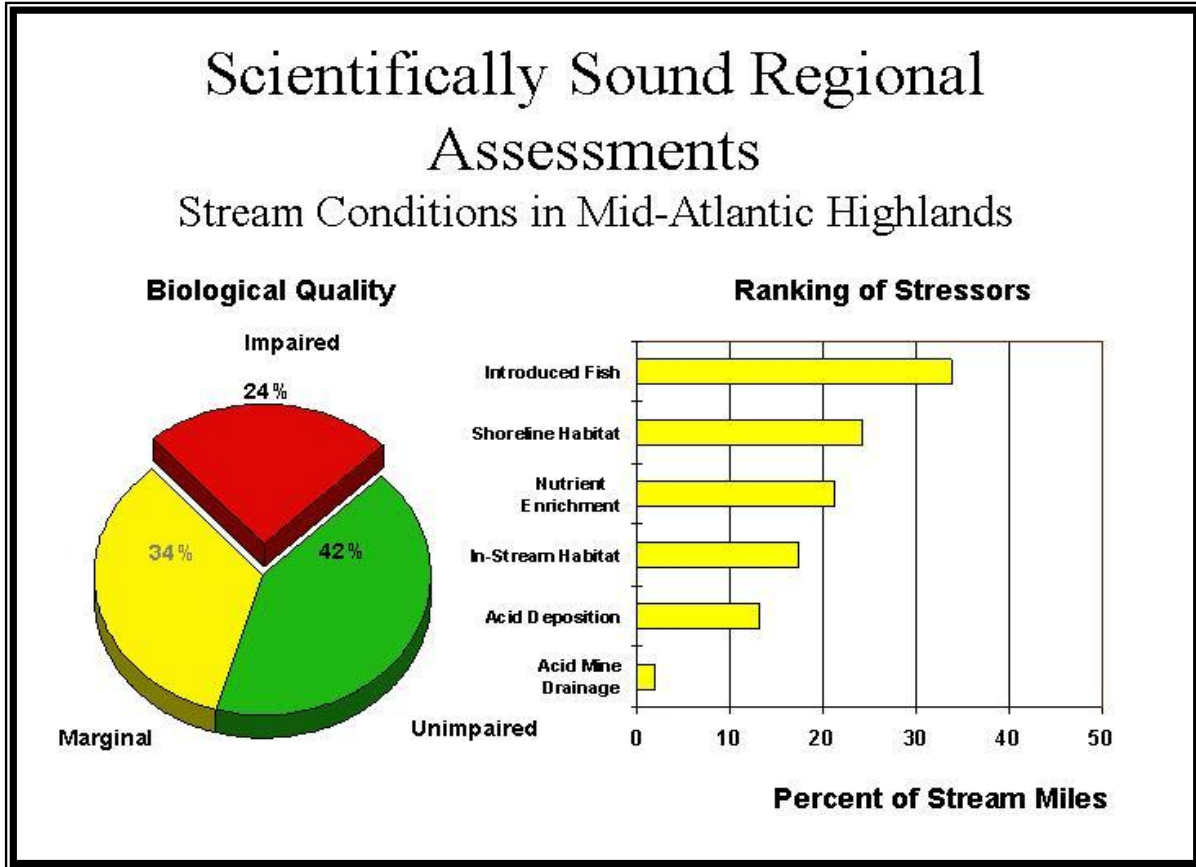
- 1) Estimate current status, trends and changes in selected indicators of Alaska's aquatic ecological resources on a regional and statewide basis with known statistical confidence;
- 2) Estimate geographic coverage and extent of Alaska's aquatic ecological resources within a known statistical confidence interval;
- 3) Seek to establish associations between selected indicators of natural and anthropogenic stresses and indications of the condition of aquatic ecological resources;
- 4) Provide for statistical summaries and periodic assessments of Alaska's aquatic ecological resources.

(Adapted from EPA, 1997)

2.0 Need for EMAP

Alaska contains over 40% of the United States freshwater resources, including its glaciers, over 20,000 navigable rivers and several million lakes. Alaska has approximately

Figure 1 – Example Graphical Statistical Summary for an EMAP Stream Assessment



45,000 miles of coastal marine shoreline, which constitute more than 50% of the total United States coastline. The surface area of coastal bays and estuaries in Alaska is 33,211 square miles, almost three times the estuarine area of the contiguous 48 states. Alaska's surface waters include over 15,000 salmon streams – an important resource to Alaskans and the world. Under the Clean Water Act (CWA) Sections 303(d) and 305(b), Alaska has the responsibility to report and identify causes and sources of water quality impairment by "*characterizing all the waters in Alaska*". This could accomplish by taking a census of all the waters in Alaska but is impracticable due to budgetary and logistical concerns. EMAP's probabilistic survey sampling provides a practical, cost effective method to characterize Alaska's coastal and surface waters. EMAP's survey design is an important tool to help resource managers, elected officials and the public see the "big picture" for large regions, with known statistical confidence, and to report on the status of Alaska's ecological resources. No similar probabilistic sampling survey studies are underway within Alaska to provide regional, ecological information on such a large scale.

Because of its design providing for the assessment of the status of ecological resources over large regions with statistical confidence, EMAP becomes an important tool to help resource managers, elected officials and the public to see the "big picture".

3.0 EMAP Statewide Assessments

ADEC is the lead agency for EMAP in Alaska. In 2001, ADEC developed a Cooperative Agreement with EPA to join collaboratively in the Western States Coastal EMAP. The Western States Coastal EMAP was initiated as one component of a national program called the National Coastal Assessment (NCA), led by EPA to survey the condition of the Nation's coastal resources (EPA, 2001). This agreement has led to completion of field surveys in two of the five Alaskan coastal provinces for which reports are currently being done.

Good scientific and statistical designs remain critical for any monitoring program attempting to assess spatial and temporal aquatic ecological resources and to reliably detect trends for making sound environmental and resource management decisions.

Recently in 2004, US EPA funded a demonstration wadeable stream EMAP survey in the interior of Alaska. This was the first freshwater EMAP project funded in Alaska, but it is a demonstration project and does not include, fish assemblages.

The main goals of EMAP from a national perspective include monitoring the condition of the Nation's ecological resources, evaluating the cumulative success of current policies and programs and identifying emerging problems before they become widespread or irreversible. These same goals are applicable at the state level. Data from EMAP sampling is envisioned as the beginning of DEC's statewide ambient water monitoring program that will include Alaska's coastal as well as fresh waters.

3.1 Coastal EMAP

Alaska is using EMAP, through the NCA, to for the first time monitor and assess the status and trends of Alaska's significant estuarine and coastal ecological resources and to develop an integrated and comprehensive coastal monitoring program.

Alaska's coastline constitutes over 50% of the total United States coastline covering approximately 45,000 miles. ADEC and EPA have established five coastal regions or provinces in Alaska: 1) Southeast Alaska; 2) Southcentral; 3) Aleutian; 4) Bering; and 5) Arctic (Figure 2). The division of Alaska's coastline into five coastal provinces facilitates planning and execution of the coastal EMAP. In the Appendix A, Figures 5-9 shows the base sample sites within the five coastal provinces.

The EMAP field survey of the Southcentral Alaska province was completed in the summer of 2002 and the final report is in progress, with completion scheduled for September 2005. EMAP sampling was conducted in an area of the northern Gulf of Alaska that encompassed the coastal bays and areas between Unimak Pass and Cape St. Elias, including Cook Inlet, Prince William Sound, and several bays near Kodiak Island. There were 50 core EMAP sites sampled in addition to 25 sites that the ADEC added to further characterize the two major waterbodies of the southcentral Alaskan coast; Cook Inlet and Prince William Sound. The entire geographic linear range across the entire study area was more than 800 miles.

The second Coastal EMAP field survey was done in the summer of 2004 in Southeast Alaska extending from Prince of Wales Island to Yakutat. A total of 40 core sites and ten cruise ship docking locations were sampled using EPA's EMAP protocol (EPA, 2001). ADEC will be conducting its evaluation and assessment of the data as it comes back from the laboratories and expects to complete the final report in 2006.

3.2 Wadeable Stream EMAP

Another component of EMAP is assessing the condition of the nation's wadeable streams and great rivers. In order to determine the extent to which Alaska's surface waters support healthy aquatic communities, ADEC is also currently involved in implementing an EMAP protocol for Alaska's wadeable streams and small rivers.

The first Alaskan wadeable stream EMAP study was conducted during the summer of 2004 and encompassed a 47,000 square mile area within Alaska's Boreal Forest Level II Ecoregion. The Tanana River and its tributaries were the focus of the 2004 wadeable streams EMAP study. The University of Alaska Anchorage (UAA), Environmental and Natural Resources Institute (ENRI) conducted the field sampling and analysis activities. Field sampling commenced in early July 2004. Water quality monitoring, physical habitat assessment and macroinvertebrate collection were conducted at 27 sample locations using EPA's Wadeable Streams Assessment protocols (EPA, 2004). Due to extreme fire conditions, only 27 sites were sampled during the summer of 2004. The remaining 23 sites will be sampled during the summer 2005. The report will be issued in 2006. Appendix A contains Figure 10, which illustrates the first 50 sampling sites.

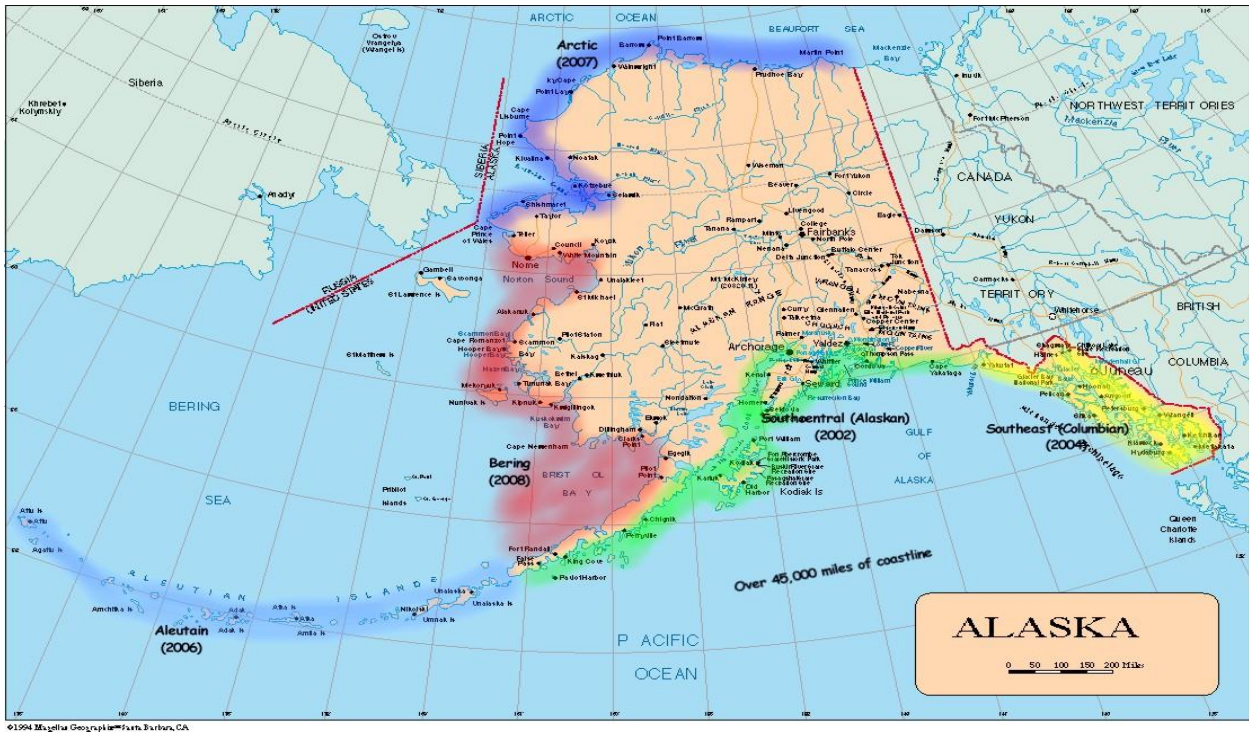
4.0 Core & Supplemental Indicators

EMAP protocols employ a **core** set of environmental indicators for each water resource type that include physical/habitat, chemical/toxicological, and biological/ecological endpoints as appropriate (EPA, 2003).

EPA recommends that this core set of indicators be monitored to provide statewide or watershed level information on the fundamental attributes of the aquatic environment and to assess water quality standards attainment and impairment status. Previously, chemical and physical indicators were emphasized, however, EPA now recommends that biological monitoring and assessment assume a more prominent role in state monitoring (EPA, 2003).

EMAP also utilizes **supplemental** indicators when there is a reasonable expectation that a specific pollutant may be present in a watershed, when core indicators indicate impairment, or to support a special study such as screening for potential pollutants of concern (EPA, 2003). Supplemental indicators are often key to identifying causes and sources of impairments and targeting appropriate source controls. Supplemental indicators may include each water quality criterion in the state's water quality standards, any pollutants controlled by the National Pollutant Discharge Elimination System (NPDES) permits, and any other constituents or indicators of concern (EPA, 2003). Basic EMAP Core and supplemental indicators are presented in Table 1.

Figure 2 – Alaska Coastal EMAP Provinces



As ADEC tests and evaluates the EMAP core and supplemental indicators changes will likely be made to reflect Alaska's ecosystems and specific environmental and resource management requirements. One example, reflecting specific ecosystem conditions, is the addition of hard bottom benthic habitat surveys to the Aleutian EMAP, because of the large percentage of the coastal zone containing hard rather than soft bottom sediments. Similar adaptations were made in Hawaii and Guam. An example of changes necessary to the freshwater EMAP would be the addition of trace metals in stream sediments to assess water quality impacts from mining activities occurring in Alaska's watersheds.

5.0 Monitoring Frequency

ADEC's current focus is to complete the initial EMAP surveys of the five coastal provinces thereby providing the first ecological benchmarks for these regions. In the national EMAP program, five years has been considered the potential recurring sample interval, but alternative sampling schemes are being developed and assessed by EPA and individual states.

Once ADEC, EPA and other partners have had the chance to assess the results of the Southcentral and Southeast Coastal EMAP sampling efforts a long term integrated probabilistic and targeted monitoring program will be implemented. Monitoring frequency cannot yet be determined, but should not be less than every five years. Monitoring frequency will also be dependent on establishing the infrastructure, stable financial resources and partnerships required to implement a comprehensive statewide EMAP program. Without building these, it is not likely that EMAP will be carried out beyond the initial EPA funding period.

Table 1 – National EMAP Core and Supplemental Indicators

Water Column Physical & Chemical Indicators	Coastal EMAP	Wadeable Streams EMAP
Dissolved Oxygen	C	C
Temperature	C	C
Turbidity	S	NR
PAR/Light Transmittance	C	NR
Conductivity or Salinity	C	C
pH	C	C
Secchi Depth	C	NR
Nutrients	C	C
Chlorophyll a	C	C
TSS & TDS	NR	C
Alkalinity	NR	C
Dissolved Organic Carbon	NR	S
Cations & Anions	NR	S
Flow or Discharge	NR	C
Sediment Physical & Chemical Indicators		
Grain Size	C	NR
Total Organic Carbon	C	NR
Sediment Bioassays	C	NR
Heavy Metal analysis	C	NR
Semi-VOC analysis	C	NR
Biological Indicators		
Macroinvertebrate Diversity/Abundance	C	C
Fish Diversity/Abundance	C	NR
Fish Tissue Analysis	C	NR
Habitat Assessment	NR	C
C = Core Indicator; S = Supplemental Indicator; NR = Not Required.		

6.0 Program Development, Support & Infrastructure

The first round EMAP coastal and wadeable stream programs are testing the EMAP assessment strategy. For ADEC this represents a “proof of concept” or a chance to test, further develop and tailor EMAP’s methods’ to Alaska’s environment, such as sampling design, indicators of condition, sampling procedures, and standardized assessment methods.

Once the initial benchmark EMAP surveys are completed, ADEC must then assess the results and then, when and where appropriate, adapt the future EMAP sampling design. The results assessment is especially important in regards to having proper indicator conditions and sampling procedures for Alaska. For example, while it is useful to have a single test species for the west coast EMAP sediment toxicity test, the test organism may or may not reflect the toxicity of the sediments to Alaska organisms. After this is done, the repeated EMAP activities can be integrated as a primary component of the statewide monitoring and assessment network.

ADEC is planning to survey the three remaining coastal regions during the next six years, but this will require an EPA commitment of funding and development of many partnerships, neither that are in place at the moment. ADEC is responsible for implementing Alaska's EMAP activities, but to enhance its technical and logistical capacity ADEC must seek out and form partnerships with other federal, state, and local agencies and organizations. Capacity building remains a crucial aspect of ADEC's initial EMAP implementation strategy for Alaska.

The existing ADEC/University of Alaska Memorandum of Understanding (MOU), recently entered into between Kurt Fredriksson, Acting Commissioner of ADEC and Craig Dorman, Vice President for Research at University of Alaska, provides a vehicle to build this capacity. Objectives of the MOU are to facilitate cooperative research effectively utilizing the unique resources of each organization, to support environmental and resource management decision-making and problem solving, and educational activities in Alaska. Two goals expressed in the MOU are of practical importance in building EMAP capacity:

- Of particular interest during the period of this MOU agreement [November 17, 2004 – June 30, 2007] are to support and enhance DEC's Environmental Monitoring and Assessment Program [EMAP] to assess the baseline water quality of Alaska's marine and freshwaters.

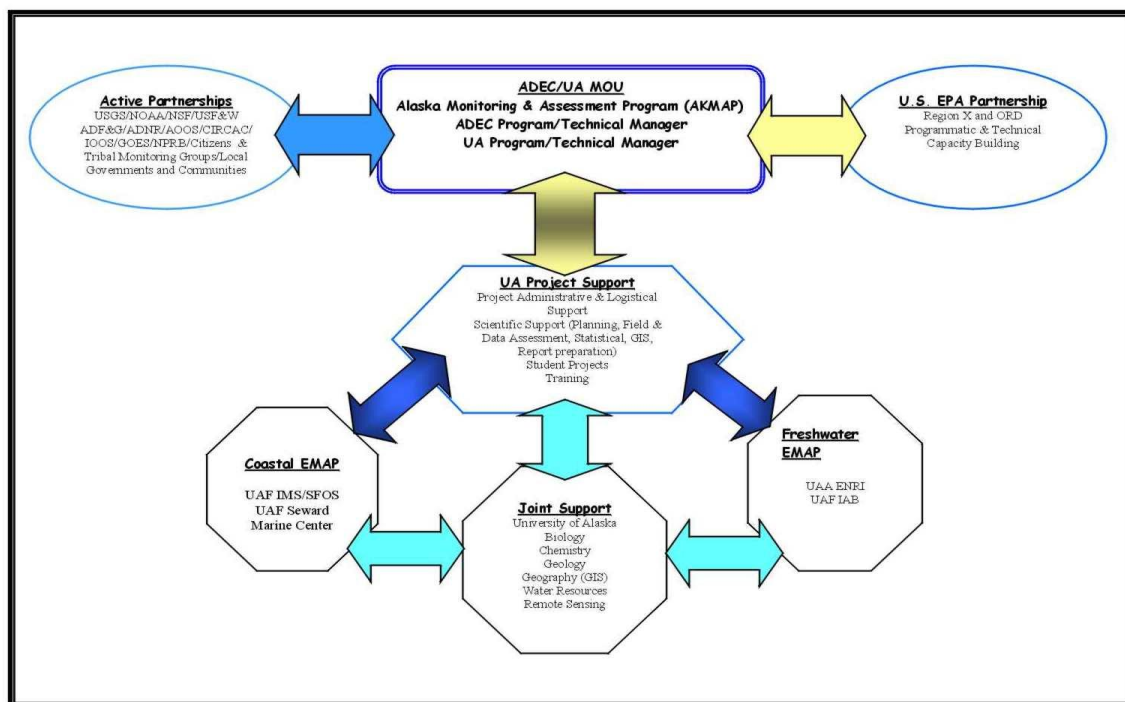


Figure 3 – Proposed AKMAP Organizational Structure

- ADEC and UA are developing conceptual and operational plans to provide for establishment of an Alaska Environmental Monitoring and Assessment Program (AKMAP) to focus on applied research on the status and trends of Alaska's air, land and water resources to support environmental and resource management decision-making.

Implementation of the AKMAP ADEC/UA cooperative under the ADEC/UA MOU provides for building long-term capacity for conducting EMAP coastal and freshwater assessments. A draft concept and organization document worked on by ADEC and UA staff involved in cooperative monitoring efforts will be completed in April 2005 for management review and approval. A draft structural outline for this cooperative is illustrated in Figure 3.

Other partnerships, using various memoranda of understanding, interagency agreements, and subcontracts with other agencies, not-for-profits, contractors, or vendors will be an important part of the implementation effort.

7.0 Priorities 2005 – 2010

Many of Alaska's current and future resource development activities and growing population centers are located along or near the Alaskan coast. Now it will be advantageous for ADEC to establish benchmark conditions for the marine and freshwater aquatic resources in these regions. These benchmarks will be an important tool for resource managers monitoring impacts from future resource development and key to building an adaptive management strategy. DEC has developed a Phase I project plan (Figure 4) to guide the EMAP planning and regional assessment activities in Alaska for the period from 2005 – 2010:

7.1 Coastal EMAP

- **Aleutian Island EMAP 2006:** This region is undergoing a rapid change in ecological resources potentially due to climate change, fishing pressures, and local and trans-boundary contaminant input.
- **Arctic coastal EMAP 2007:** This region has seen increased resource development with mining activity, existing oil industry, possible expansion of the oil fields, and increases in populations in the coastal communities.
- **Bering Coastal EMAP 2008:** This region has seen rapid change in the ecosystems, especially the fisheries, potentially due to climate change, and increasing fishing pressures.
- **Southcentral Coastal EMAP 2010:** This will be a reassessment of the first coastal site sampled in Alaska and will begin the implementation of the long-term monitoring/assessment network to assess trends in Alaska's aquatic ecological resources.

7.2 Freshwater EMAP

- **Interior Alaska Wadeable Stream EMAP 2006:** This demonstration project is being undertaken to assess the status of wadeable streams in a region where new resource development is taking place and the human population is growing.
- **Kenia Regional EMAP 2006:** Streams, rivers and lakes in this area of Alaska are seeing increased pressure from the growing human population and a regional EMAP assesment will provide a needed understanding of the extent of current impairment.
- **Tanana River Main Channel EMAP 2007:** Many Alaska Native communities along the Tanana and Yukon River are concerned with water quality impacts from the

- increasing population centers along the Tanana and resource development activities occurring in this area. Conducting an EMAP survey of the main Tanana River
- **Naval Petroleum Reserve/North Slope 2007:** No benchmark exists on Alaska North Slope for freshwater resources that may be impacted by oil and gas extraction activities. Adaptive resource management cannot be practiced without the type of benchmarks that EMAP surveys produce.
 - **Yukon River Watershed 2010:** The Yukon River is the fourth largest river in North America, and flows from east to west across the entire state of Alaska. ADEC would like to implement an EMAP program focusing on the Yukon River and its tributaries.

DEC should also take advantage of grant opportunities that are insufficient to fund large regional projects in the Phase I plan but sufficient to fund smaller projects such as the following:

- **Lower Kenai Peninsula Regional EMAP:** Streams, rivers and lakes in this area of Alaska are seeing increased pressure from the growing population and a regional EMAP assessment will provide a needed understanding of the extent of current impairment.
- **Tanana River Main Channel EMAP:** Many Alaska Native communities along the Tanana and Yukon River are concerned with water quality impacts from the increasing population centers along the Tanana and resource development activities occurring in this area. Conducting an EMAP survey of the main Tanana River.

8.0 Application of EMAP Data

As the data is collected, compiled, and evaluated, ADEC will be able to describe Alaska's coastal and freshwater benchmark conditions for water chemistry, for toxic compounds in sediment and fish tissue, and for benthic infauna and demersal fish distribution and abundance. These data may be used in future focused studies targeting specific locations that exhibit elevated levels of toxic compounds in sediment or fish tissue, show anomalies in benthic infauna or show anomalies in fish pathology, distribution or abundance.

Data gathered by the EMAP may be used to:

- Determine the extent Alaska's streams, lakes, and coastal waters meet some pre-determined reference or water quality condition.
- Determine if an association exists between the status of aquatic resources and the most important natural or anthropogenic stresses.
- Help to determine the effectiveness of ADEC's pollution control measures.
- Revise, develop or modify existing water quality standards.
- Help develop new water quality criteria, such as nutrients.
- Integrate repeated EMAP assessments to assess and forecast trends in monitored indicators into adaptive management practices.
- Evaluate if ADEC is making the correct regulatory decisions for protecting Alaska's aquatic resources.

9.0 Bibliography

EPA. 1997

EPA. 2001. National Coastal Assessment Field Operations Manual, Environmental Monitoring and Assessment Program, Office of Research and Development, U.S. EPA, Washington, DC. EPA/620/R-01-003, June 2001.

EPA. 2004. Wadeable Streams Assessment, Field Operations Manual. Office of Water, US EPA, Washington, DC. EPA-841-B-04-004, July 2004.

Appendix A: Coastal EMAP Provinces & Tanana River Drainage EMAP Wadeable Stream Maps

Figure 4.EMAP Project Plan for Alaska: Phase 1.

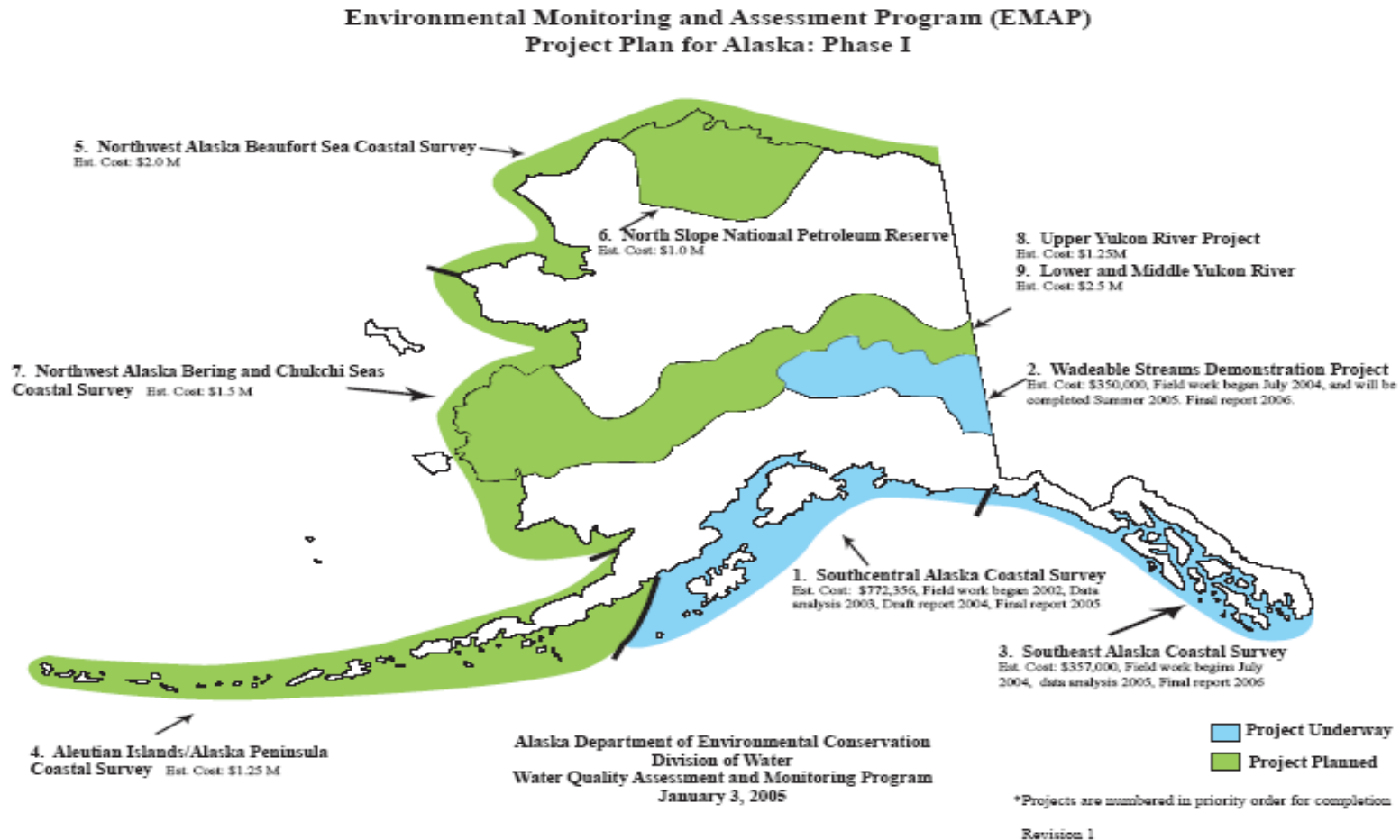


Figure 5 – Southcentral Coastal EMAP Sites Sampled in 2002



Figure 6 – Southeast Coastal EMAP & Cruise ship Sites Sampled in 2004

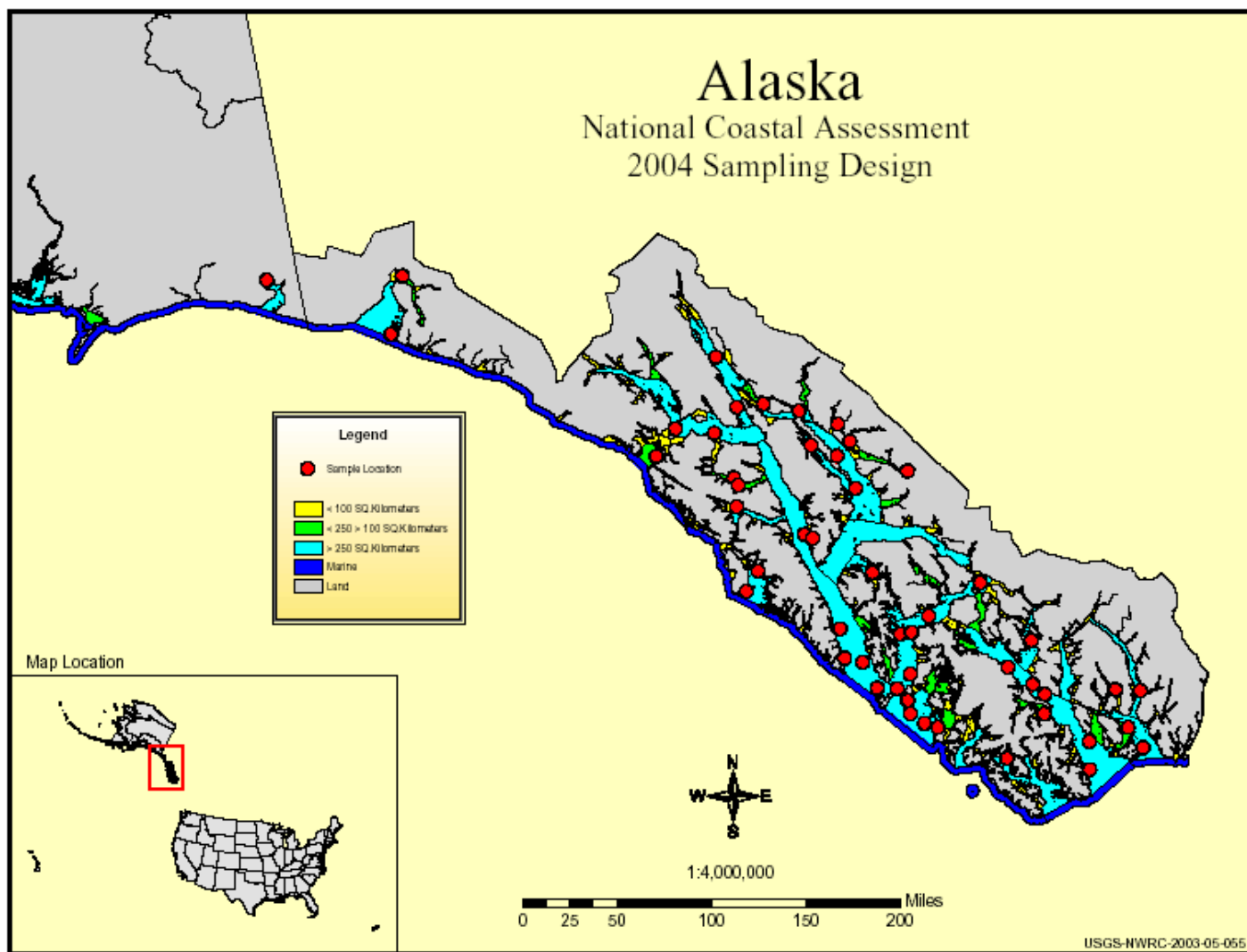


Figure 7 – Aleutian Coastal EMAP Base Sites for 2006 Field Survey

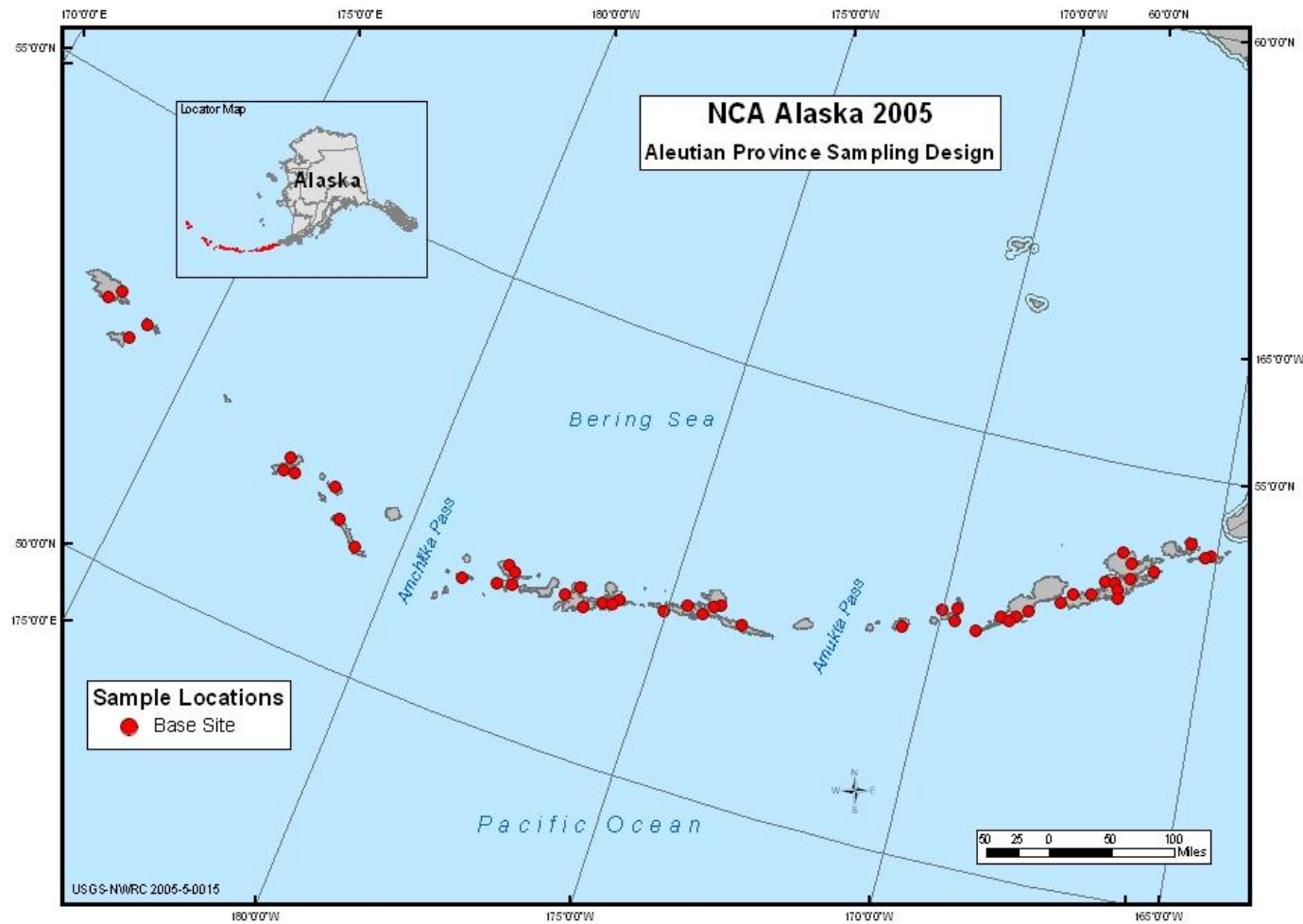
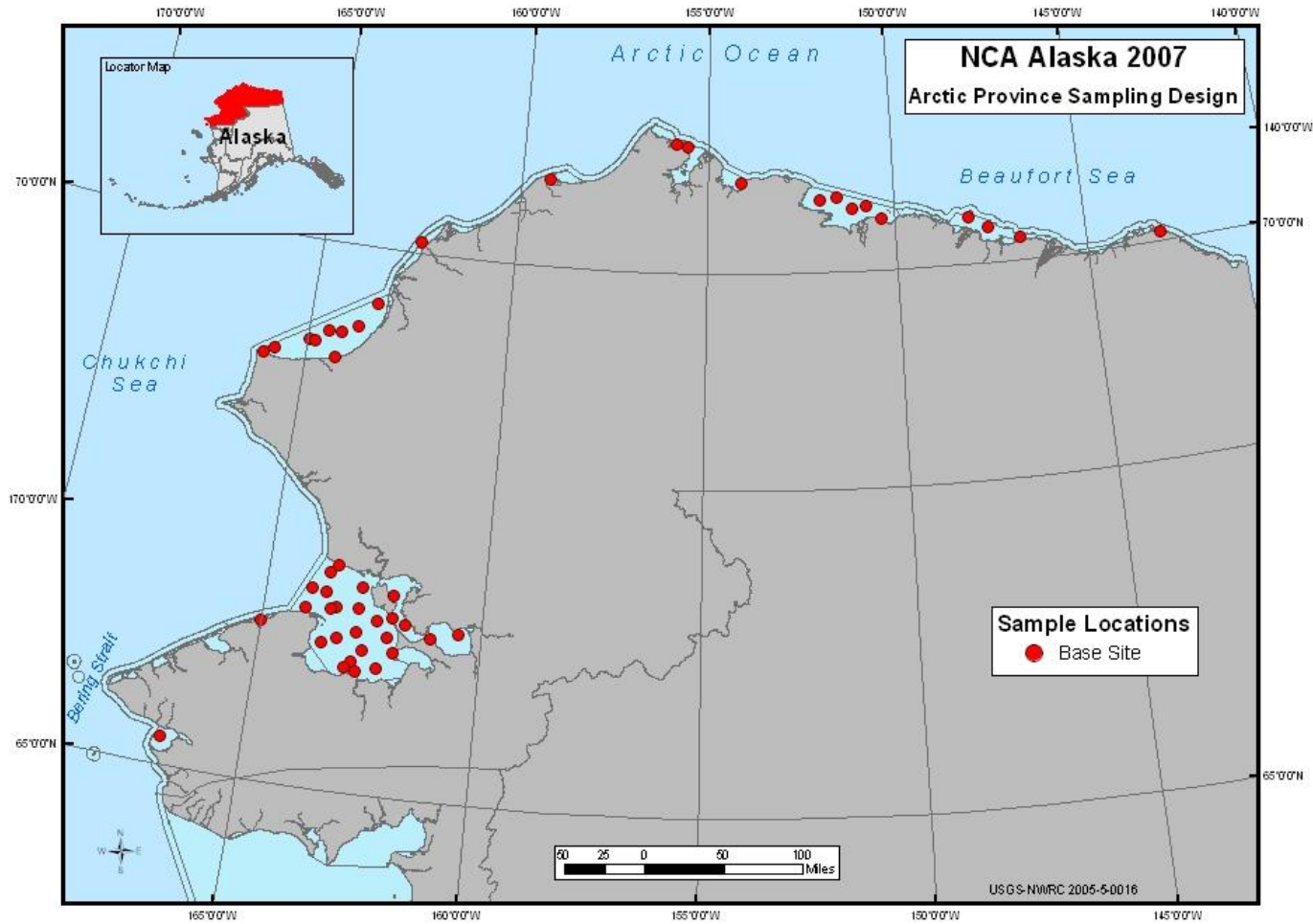
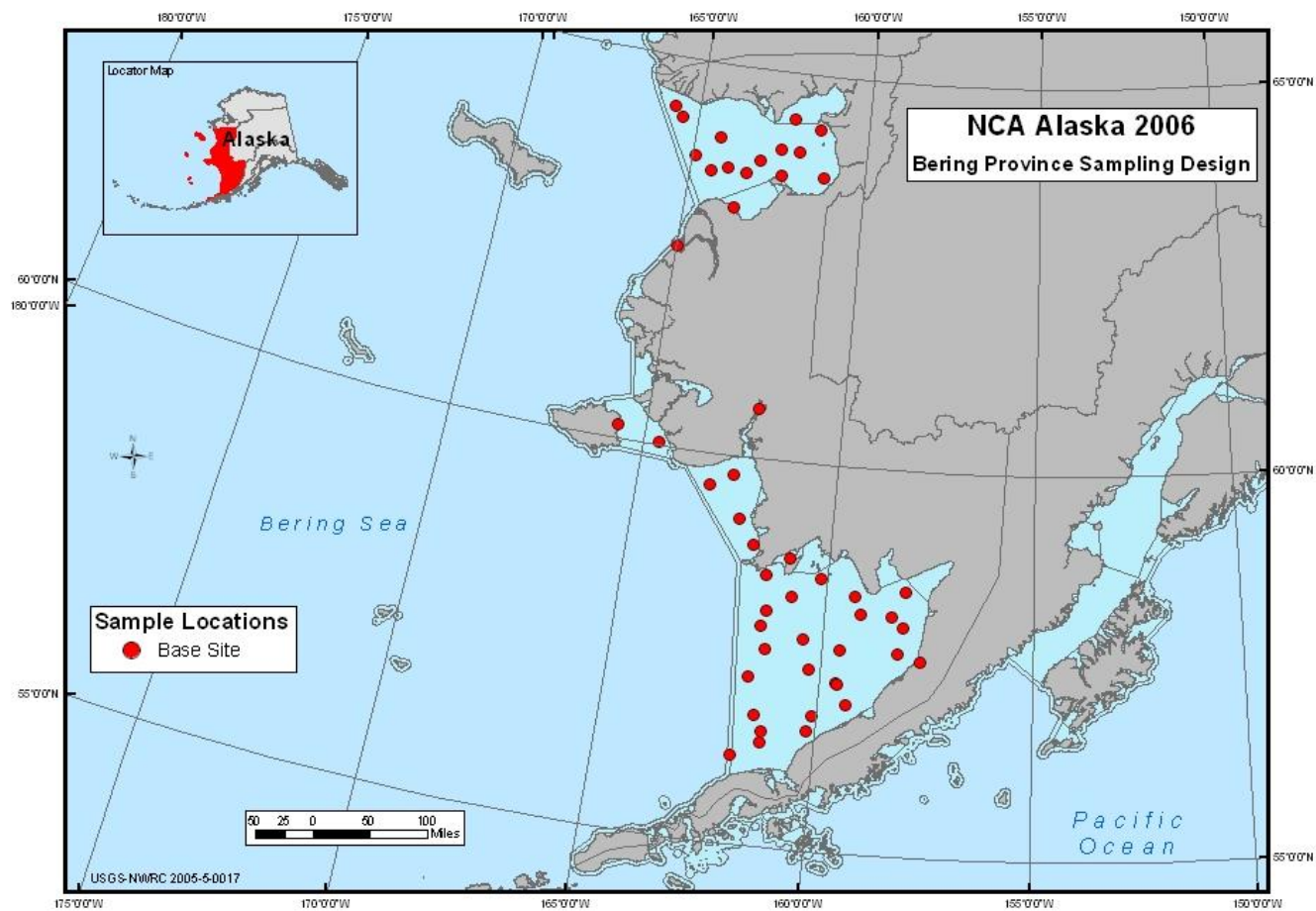


Figure 8 – Arctic Coastal EMAP 50 Base Sample Sites for 2007



This is a preliminary site selection and the target frame is being modified. Sample locations will change.

Figure 9 – Bering Coastal EMAP 50 Base Sample Sites for 2008



This is a preliminary site selection and the target frame is being modified. Sample locations will change.

Figure 10 – Interior Alaska EMAP Demonstration Wadeable Stream Sample Sites

